Suggesting ways to minimize Light Bill (CSP)

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B18CSE37
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OVERVIEW

In the period of lockdown during the “Corona” pandemic everyone was forced to stay back at home.This was the period when most of the people started complaining about significant increase in their light bills.Most people believed that they cannot use that much light so the light bills were just fraud. But everyone was really worried about how they can lower their light bill as for many of the middle class families a light bill of Rs.1000 is a significant amount. This is the inspiration behind the project.
This project takes input from user about how many electronic devices they have,the least time they want those devices to be working, which device they think is should get more time increase and which one should get less and which one has enough time and need not increase.This project also takes light bill amount they expect and then gives suggestions about how many time should we keep on those devices so as to get light bill around that expected amount.
This problem is formulated as Constraint Satisfaction problem and constraints are decided by the user.So there are no fixed constraints and this is what increases it’s difficulty.Program uses backtracking algorithm for CSPs under the hood and then 10 best alternatives are given to the user.

PROBLEM STATEMENT AND SPECIFICATION

We have to suggest best ways to the user to minimize the light bill so that it does not increase more than expected by the user. Users can decide which of their electronic devices should get more time which should get moderate time and which have enough allotted time. Then according to those constraints we have to suggest best alternatives which yield light bills between (expected-100 and expected+100).There are no heuristics used to solve the problem. This problem could also be solved using Genetic algorithms but here we have tried to solve this problem as a CSP.

Problem Formulation

Variables - Quantity,minimum time and priority of the electronic devices and Expected light bill amount
Domain - Any positive rational number
Constraints - Quantity >=0
Minimum Time >=0 and Minimum Time <= 24
Expected Light Bill >= 0

BACKGROUND SURVEY

There are some projects based on Genetic algorithms and Linear Programming which aim to minimize the budget of an industry power. But there are no projects which aim to control the household light bill budget.

DISCUSSION

The novelty of this project is that it focuses on household problems. Many people use a minimum of their appliances to lower their light bill and yet there are times when the light bill increases beyond their expectation. This may not be a problem for rich people but for poor ones it is a big problem. This project tries to help them so that they can use their appliances according to one of the suggested alternatives according to their preferences and yet live carefree about their light bill surging higher.

ALGORITHM

The best suitable algorithm for this problem is backtracking. Algorithms like A* search and others won't work because here we are not trying to find just one perfect solution. The solution need not be perfect but should be convenient to the user.

There are three types of restrictions on usage of every appliance namely ‘Low’ , ‘Medium’ , ‘High’. The algorithm first allocates maximum possible time to appliances having low restriction. After that problems with medium restriction are considered. The algorithm does not increase time for appliances with high restrictions as users think that the time allotted to those appliances is already enough.
The algorithm does not allot time more than 18 hours to appliances having medium restriction and appliances having low restriction obviously cannot grab time more than 24 hours. If the minimum cost is greater than the expected amount then the program asks the user to reset their preferences and expected amount.

There are algorithms like Genetic algorithm and Linear Programming which have high efficiency and are able to give accurate information.These types of algorithms are used in industries to lower their budget on power consumption.

COMPLEXITY ANALYSIS

HQ = Quantity of appliances with high restriction
MQ = Quantity of appliances with medium restriction
LQ = Quantity of appliances with low restriction
MT = Time allotted to appliances with medium restriction
LT = Time allotted to appliances with low restriction

Time Complexity :

O(HQ * MQ * MT * LQ * LT)

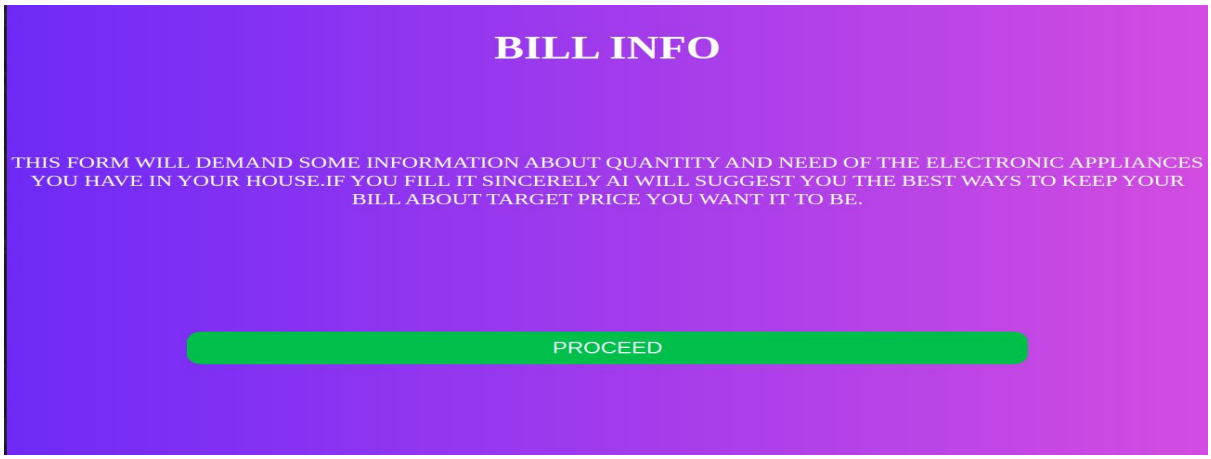
Space Complexity :

O(all possible combinations with constraints)

DEMO

Following are attached pictures of application windows.

INSTRUCTION WINDOW



Give quantity and least the appliance should be kept on. Give restrictions.
Note: There are many more input windows.only one is shown here

THE SUGGESTION WINDOW

Total Suggestions 2

Alternative 1

Total Cost : 2940.0

TubeLight	Bulb	TV	Laptop	Mobile	Fridge	Fan
2	1	5	10	8	24	20

Alternative 2

Total Cost : 2994.0

TubeLight	Bulb	TV	Laptop	Mobile	Fridge	Fan
2	1	5	10	8	24	21

CONCLUSION

We can finally conclude that using backtracking is little time consuming but it is suitable for this problem as it can search through every possibility efficiently and give suggestions according to the user's preferences. Only top 10 of the suggestions are taken which are biased to appliances with low restrictions and hence are convenient to users.

References

https://www.tutorialspoint.com/python_data_structure/python_backtracking.htm
https://www.geeksforgeeks.org/backtracking-algorithms/